



A Systematic Review of Internet of Things (IoT) Applications in Sustainable Project Management in Ethiopia

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Abstract: *The rapid advancement of Internet of Things (IoT) technologies has created significant opportunities for sustainable project management in developing countries, including Ethiopia. As Ethiopia advances initiatives such as the Digital Ethiopia 2030 strategy, smart city programs, and climate-resilient development policies, IoT integration has become increasingly important in infrastructure, agriculture, energy, and environmental management. This systematic review examines the current applications, benefits, and challenges of IoT in sustainable project management within the Ethiopian context. The study employed a structured review methodology using academic databases, institutional repositories, government publications, and peer-reviewed literature. A total of 23 relevant studies and policy documents were critically analyzed using thematic synthesis approaches to identify sectoral applications, sustainability contributions, and implementation barriers. The findings indicate that IoT applications in Ethiopia are concentrated in construction and infrastructure, agriculture, energy systems, and environmental monitoring. IoT technologies improve economic sustainability through operational efficiency, resource optimization, and reduced maintenance costs. Environmental sustainability benefits include real-time monitoring of ecosystems, efficient resource utilization, and climate resilience. Social sustainability outcomes involve enhanced food security, infrastructure safety, and public service reliability. However, adoption remains constrained by inadequate infrastructure, high implementation costs, limited technical expertise, cybersecurity concerns, and weak institutional coordination. The study concludes that IoT technologies possess substantial potential to support sustainable development in Ethiopia. The review recommends increased investment in digital infrastructure, technical capacity building, localized innovation, and stronger regulatory and cybersecurity frameworks..*

Keywords: *Internet of Things, Sustainable Project Management, Digital Ethiopia 2030, Smart Infrastructure, Environmental Sustainability*

I. Introduction

The fusion of digital technologies with project management has emerged as a transformative force in addressing sustainable development challenges globally. Among these technologies, the Internet of Things (IoT) referring to networks of interconnected sensors and devices that collect, transmit, and act upon real-time data holds particular promise for enhancing the efficiency, transparency, and sustainability of project execution. In Ethiopia, where rapid urbanization, infrastructure expansion, and climate vulnerability intersect, the strategic application of IoT within project management frameworks offers a pathway to address pressing environmental and developmental priorities.

The concept of sustainable project management integrates economic viability, social equity, and environmental stewardship into the project lifecycle. IoT technologies can contribute to this triad by enabling remote monitoring, optimizing resource allocation, reducing waste, and supporting data-driven decision-making. However, the adoption of IoT in developing countries such as Ethiopia is not merely a technological question; it is embedded within socio-economic constraints, infrastructural deficits, and institutional capacities that shape both opportunities and limitations.

This systematic review collates and critically evaluates the available evidence on IoT applications in sustainable project management within the Ethiopian context. Specifically, it aims to: (1) identify the range and scope of IoT applications across project sectors in Ethiopia; (2) assess documented benefits and challenges; (3) examine the alignment of these applications with sustainable development goals; and (4) identify gaps in the literature and directions for future research.

II. Research Methods

2.1 Search Strategy

This review follows the principles of systematic evidence synthesis (Moher et al., 2009). A structured search strategy was employed across multiple academic databases and institutional repositories. Search terms were developed around three core concepts: (“Internet of Things” OR “IoT” OR “wireless sensor networks” OR “smart”) AND (“project management” OR “infrastructure” OR “sustainable” OR “monitoring” OR “climate adaptation”) AND (“Ethiopia” OR “Ethiopian”). Databases searched included IEEE Xplore, Scopus, DOAJ (Directory of Open Access Journals), Google Scholar, and Ethiopian university repositories (Addis Ababa University, St. Mary’s University, Jimma University). Additional grey literature was identified through the GSDRC’s rapid evidence reviews, the International Growth Centre (IGC), and market intelligence sources. The search period covered publications from 2019 to 2026, reflecting recent developments in Ethiopia’s digital transformation landscape.

2.2 Inclusion and Exclusion Criteria

Inclusion criteria required studies to: (a) focus on IoT or related sensing technologies; (b) address Ethiopian applications or contexts; (c) relate to project management, infrastructure development, climate adaptation, or sustainability outcomes; and (d) be published in English. Exclusion criteria eliminated studies that were purely conceptual without empirical grounding, those that addressed IoT at a purely global level without Ethiopian relevance, and non-peer-reviewed reports without methodological transparency.

2.3 Study Selection and Data Extraction

A total of 78 records were initially identified across all sources. After deduplication and title–abstract screening, 43 full-text articles were assessed for eligibility, with 23 included in the final synthesis. Data extraction focused on sector of application, technology type, sustainability dimensions addressed, reported outcomes, and identified barriers.

III. Result and Discussion

3.1 Overview of IoT Applications across Sectors

The evidence reveals that IoT applications in Ethiopia span multiple sectors, with the highest concentration in construction and infrastructure, agriculture, energy, and environmental monitoring. Table 1 summarizes the distribution of applications by sector and sustainability dimension.

Table 1: Distribution of IoT Applications in Ethiopia by Sector and Sustainability Dimension

Sector	Number of Studies	Primary Sustainability Dimension	Key Technologies
Construction / Infrastructure	7	Economic / Social	Wireless sensor networks, BIM, SCADA, sensors
Agriculture	6	Environmental / Economic	Soil sensors, NPK monitoring, smart irrigation
Energy	4	Environmental / Economic	Smart meters, smart grid, IIoT
Environmental Monitoring	3	Environmental	GSM/GPRS, Arduino, ThingSpeak
Urban / Smart Cities	3	Economic / Social / Environmental	LPWAN, 5G, CCTV, eDAS
Total (with overlap)	23	All three	Multiple

3.2 Construction and Infrastructure Project Management

The construction sector represents the most extensively documented domain for IoT applications in Ethiopia, driven by the country’s ambitious infrastructure agenda. A foundational study by Asefa (2024) evaluating the influence of technology on project development and administration in Ethiopia found that technology explains 76.0% of the variance in project success, with strong positive relationships between technology utilization and key performance indicators including budget adherence and communication efficiency. Notably, 46.4% of survey respondents reported not using any technology, highlighting persistent barriers related to training and infrastructure (Asefa, 2024).

Research on critical success factors for road construction in Dessie, Ethiopia, identified 26 CSFs grouped into six domains: resource, stakeholder, communication, risk, budget, and time management (Demeke, 2025). The study proposed a hybrid framework integrating traditional methods with intelligent construction tools including building information modeling (BIM), AI-driven risk forecasting, and drone-assisted monitoring (Demeke, 2025). The findings demonstrated that intelligent construction integration enhances planning accuracy, stakeholder coordination, and project resilience.

A thesis examining railway infrastructure monitoring at Addis Ababa University developed a wireless sensor network (WSN) framework for real-time safety monitoring of railway bridges, demonstrating the technical feasibility of automated railway monitoring (Mbewe, 2018). Complementing this work, Fenta et al. (2025) introduced WSN node deployment strategies for the Ethio-Djibouti railway route (639 km), emphasizing advantages including low cost, ease of installation and maintenance, low energy consumption, increased line capacity, and real-time monitoring data. The study employed a non-uniform node deployment algorithm to mitigate the “energy hole” phenomenon that decreases network lifetime (Fenta et al., 2025).

Market intelligence data indicates that the Ethiopia IoT in commercial construction market is segmented by application (equipment monitoring, safety and security, smart buildings, workforce

management), component (hardware including sensors/RFID/cameras, software, services), and connectivity type (Wi-Fi, LPWAN, Bluetooth, cellular networks) (6Wresearch, 2025). This segmentation reflects the growing commercialization of IoT solutions, although adoption remains concentrated in larger-scale commercial and infrastructure projects.

3.3 Agricultural Project Management

Agriculture represents the second most heavily researched sector for IoT applications, with a strong emphasis on climate adaptation and sustainable resource management. The relevance of IoT to agricultural project management is particularly acute given Ethiopia's vulnerability to climate variability and the predominance of smallholder farming systems.

Wuletaw et al. (2022) developed a smart farming system using IoT sensors (moisture, temperature, pH, and NPK sensors) to collect soil mineral and environmental condition data, combined with a decision tree machine learning algorithm to predict optimal crops for cultivation. The model achieved 97% accuracy in predicting suitable crops for the Jiren kebele area in Jimma Zone, demonstrating the potential for data-driven agricultural planning (Wuletaw et al., 2022).

Representing Ethiopia, Zelalem Endalew won a gold medal at the 2025 BRICS Skills Competition for his IoT-Based Smart Irrigation Controlling and Monitoring System, which measures eight types of soil data including NPK, moisture, temperature, pH value, and electrical conductivity (ENA, 2025). Deployed in Ethiopia's Somali and Afar regions, the system empowers remote farmers with no access to electricity or formal education to manage crops effectively.

A water and pasture monitoring forecasting and early warning system developed through collaboration with Ethiopia's Ministry of Agriculture and the Ethiopian Institute of Agricultural Research integrates real-time satellite data with seasonal forecasts and local field observations (Alemayehu, 2025). The system tracks water points and grazing areas across Ethiopia's drylands, predicting changes over days, weeks, and months. Information is disseminated through SMS, FM radio, websites, and community-run information centers (FDRE Ministry of Agriculture, 2025). In Haro Bakee, local authorities now use the system to plan water trucking before shortages hit, while herders receive alerts enabling them to move animals before grazing areas become depleted. By helping anticipate resource pressure points, the system contributes to reduced conflict over resources increasingly urgent issue in drought-prone regions (Alemayehu, 2025).

A comprehensive review by Gebremedhin et al. (2024) explored the potential of integrating ML, DL, and IoT technologies in Ethiopian agriculture, emphasizing that data-driven insights enable optimized resource allocation, increased productivity, and real-time monitoring of agricultural operations. The review noted challenges including data quality, connectivity issues, and the need for farmer education (Gebremedhin et al., 2024).

3.4 Energy Sector Projects

The energy sector has seen significant IoT applications, primarily focused on grid modernization and efficiency improvement. The Ethiopian Electric Utility (EEU), in partnership with the Karlsruhe Institute of Technology (KIT) and GIZ, launched the Smart-e-Meter initiative to develop intelligent low-cost IoT energy meters tailored to Ethiopian distribution networks (KIT, 2023). Building on this, a Memorandum of Understanding signed in March 2026 established long-term cooperation for digital innovations in Ethiopia's electricity distribution grid, including the MoRaU project (Monitoring and Modelling of Urbanization in Sub-Saharan Africa) to design digital tools supporting planning, monitoring, and operation of the expanding distribution grid (KIT, 2026).

Research field-tested in Harar, Ethiopia, developed a low-cost smart grid monitoring solution specifically designed for unorganized energy systems in developing countries (Lehner & Stork, 2024).

The solution offers a practical approach for imbalance loading and loss analysis, paving the way for more stable and efficient energy systems. The paper notes that technological advancements in

embedded microcontrollers and low-power modulation techniques have significantly reduced the cost of monitoring solutions, making smart grids feasible even for chaotic energy systems in developing regions (Lehner & Stork, 2024).

A randomized controlled trial examining smart meters for Ethiopian SMEs revealed that firms face frequent power outages and weak electricity systems (Demeke et al., 2026). Ethiopian SMEs experience, on average, nearly 24 power outages per month, and 71% have no backup power source.

Poor billing systems, electricity theft, and limited grid monitoring prevent EEU from generating sufficient revenue to invest in infrastructure, creating a vicious cycle of revenue loss and underinvestment. Awareness of smart meters is low: only 33% of firms had heard of the technology at baseline, suggesting rollout should be paired with targeted information campaigns (Demeke et al., 2026).

3.5 Environmental Monitoring Projects

Environmental monitoring represents a growing application area, particularly aligned with Ethiopia's Green Legacy Programme. Garuma (2021) developed an IoT-based prototype for monitoring environmental conditions for urban tree plantation and growth, using GSM/GPRS modules, Grove sensors, DHT11 sensors, Arduino microcontrollers, and the ThingSpeak platform. The study found that the automation process reduced human interaction and improved efficiency, addressing the challenge that stewardship activities such as watering and air pollution removal are rarely tracked consistently after trees are planted (Garuma, 2021).

3.6 Urban and Smart City Development

The national policy framework is increasingly supportive of IoT deployment. The Digital Ethiopia 2030 Strategy, launched by Prime Minister in December 2025, aims to strengthen Ethiopia's technological capacity and enable the benefits of the digital economy (Addis Media Network, 2025). The strategy is implemented in close coordination with Addis Ababa's Smart City development plan, with modern electric poles now integrating internet connectivity, CCTV surveillance, and 5G network services into a unified infrastructure system (Addis Media Network, 2025).

The Ministry of Urban and Development has unveiled a smart city initiative to transform towns across Ethiopia, with pilot projects implemented in Addis Ababa, Adama, Bishoftu, Debre Birhan, Dessie, Jimma, Hawassa, and Bahir Dar. The national digital addressing system (eDAS) is being implemented in 73 cities across Ethiopia to improve the efficiency and accessibility of administrative, economic, and social services while supporting sustainable development goals (Ethiopian Space Science and Geospatial Institute, 2024).

3.7 Challenges for Implementing Project Management: Corruption at Different Levels

Corruption remains one of the most formidable barriers to effective project management in Ethiopia, particularly within the construction and infrastructure sectors. A comprehensive framework document from the Ethiopian Ministry of Urban and Infrastructure (2025) identifies corruption as a "pervasive and deeply embedded practice" that manifests in various forms, including collusion during tendering, fraudulent billing, substandard work, and manipulation of procurement processes. The construction sector's inherent vulnerability stems from several characteristics: large and complex project budgets, difficulty in verifying material usage and labor inputs, and the multiplicity of stakeholders involved in decision-making. A comprehensive study on dam construction corruption in Ethiopia (Ali Mohammed, 2024) found that weak management practices,

insufficient oversight, and centralized decision-making contribute to inflated costs, significant delays, and compromised construction quality, with information asymmetry and misaligned incentives enabling corrupt practices at multiple stages.

Forms and Scale of Corruption in Ethiopian Project Management

The empirical evidence reveals that corruption occurs systematically across the project lifecycle, from planning and procurement through implementation to payment and certificate settlement. A study by the Federal Ethics and Anti-Corruption Commission (FEACC) examining irrigation and lowland development projects documented widespread practices including bribery, embezzlement, fraud, document forgery, fake bids, and favoritism (FEACC, 2025). The report found that four large-scale irrigation budgets remained incomplete despite taking up a combined 30 billion Birr in supplementary budgets, with projects in progress for up to ten times longer than originally planned. The Megech irrigation project alone consumed over 18 billion Birr—more than seven times its initial 2.4 billion Birr estimate—and remained incomplete after 17 years, with the original contractor replaced without proper financial assessment of the successor firm (FEACC, 2025). Across 20 projects under the Ministry of Irrigation and Lowlands, each receiving up to 15 billion Birr in annual budget allocations, only two-thirds of allocated funds were effectively utilized (FEACC, 2025). In the road construction sector, parallel investigations revealed that 127 road projects in the 2023/24 fiscal year required 267 billion Birr indicating systematic budget overruns that point toward procurement irregularities rather than genuine technical challenges (FEACC, 2025). A procurement report highlighted that politically sensitive projects, including large-scale event logistics, technology deployments, and contracts were increasingly awarded without open competition, with alleged favoritism toward companies perceived as close to the ruling coalition or individual cabinet members (The Reporter Ethiopia, 2025). An audit of 41 projects revealed a loss of 17 billion Birr, with widespread financial mismanagement documented across 162 federal agencies during the 2022/23 fiscal year (Ethiopian Auditor General, 2024).

Root Causes and Contributing Factors

Ali Mohammed (2024) identified that corruption in Ethiopia's infrastructure projects is driven by information asymmetry between principals and agents, rent-seeking behavior by officials, weak institutional frameworks, and neo-patrimonial governance structures. A framework document (Ministry of Urban and Infrastructure, 2025) elaborates that corruption manifests across five distinct phases: (1) policymaking and regulatory processes, where discretionary powers create opportunities for influence peddling; (2) project management and oversight, where weak monitoring enables concealment of mismanagement; (3) tendering and procurement, where collusion and bid rigging undermine competition; (4) construction operations, where substandard material usage and falsified progress reports are common; and (5) payment and certificate settlement, where inflated claims and fraudulent certificates divert public funds.

A government-wide assessment identified poor-quality construction, inflated costs, delayed project implementation, unequal contractual relationships, weak enforcement of professional standards, and discretionary powers as key warning signs of corruption (Ministry of Urban and Infrastructure, 2025). The report noted that discretionary powers granted to ministers and government officials to order special procurement permits and enact direct procurement severely undermine efforts to minimize corruption (The Reporter Ethiopia, 2025). A leading commentator observed that political prestige often overtakes careful planning, feasibility studies, and transparency in Ethiopia's mega projects, leading to unsustainable debt burdens, environmental degradation, and disruption of local communities without delivering intended benefits (The Reporter Ethiopia, 2025). For example, sugar projects initiated earlier collapsed due to poor design, corruption, and lack of preparation, leaving incomplete factories and wasted billions (The Reporter Ethiopia, 2025).

Emerging Technological Countermeasures

In response to these challenges, the Ethiopian Construction Authority, in collaboration with the Information Network Security Administration (INSA), has launched the Construction Regulation Information System (CRIS) in October 2025, specifically designed to address the lack of integrated and accountable monitoring that had previously allowed corruption to flourish (INSA, 2025). The Minister of Urban and Infrastructure emphasized that manual inspection and monitoring practices had allowed for widespread corruption and lack of accountability, stressing the need for a system that enhances transparency and reduces misconduct (INSA, 2025). The government has implemented several complementary digital governance initiatives. Ethiopia's Deputy Prime Minister called for a technology-led overhaul of the country's anti-corruption law enforcement mechanisms, urging all relevant bodies to prioritize upgrading their systems and processes through technology, stating that "data, digital platforms, and collaborative technologies" are essential for ensuring accountability and efficiency (FurtherAfrica, 2025). The Federal Ethics and Anti-Corruption Commission, in collaboration with the Ethiopian Artificial Intelligence Institute, developed the National Corruption Crime Reporting Digital System (NCRS), which provides a robust platform that properly protects the confidentiality of information while enabling citizens to securely report corruption from any location (ENA, 2024). Since its introduction, the Commission has reported receiving increased reports of corrupt activities, with citizens able to submit signs of corruption incidents or suspicious activities in a secure manner without wasting time or resources (Ethiopian Press Agency, 2024).

The Public Procurement Service (PPS) has been transitioning to an electronic government procurement system (e-GP), with contract administration recently integrated into the platform. Once fully operational, the system is expected to monitor procurement activities more closely and reduce irregularities throughout the procurement cycle (TrendsNAfrica, 2026). However, experts caution that digitizing the e-GP system alone cannot protect public procurement from corruption as long as ministers and government officials retain the legal power to order special procurement permits and enact direct procurement (The Reporter Ethiopia, 2025). A study on digital technologies in Ethiopia found that blockchain has potential to enhance customs transparency and efficiency, AI to expedite cargo clearance and strengthen fraud detection, and IoT to provide improved supply chain visibility, though the research noted that cybersecurity risks (87%), data privacy concerns (75%), and implementation complexity remain significant obstacles (Tesfaye et al., 2025). The research found that only 10% of firms currently use AI despite 67% recognizing its value for fraud detection, indicating a substantial adoption gap between awareness and implementation (Tesfaye et al., 2025).

3.8 The Overall Efficiency of Project Management with IoT

The literature consistently demonstrates that IoT integration significantly enhances project management efficiency across multiple dimensions, including real-time monitoring, resource optimization, safety improvement, data-driven decision-making, and lifecycle management. A systematic review of 77 peer-reviewed publications published between 2019 and 2025 (Tighnavard & Sher, 2026) identified that IoT applications in sustainable construction project management have increased dramatically since 2023, with real-time monitoring, wireless sensor networks, safety improvement, BIM and digital twin integration, and resource and energy optimization emerging as the five main application domains. The review highlighted a marked transition from standalone

sensing applications to integrated, intelligent, and predictive systems that enable data-driven decision-making throughout the construction lifecycle (Tighnavard & Sher, 2026).

A complementary scientometric review of 428 papers published between 2010 and 2024 (Sadeghi et al., 2026) found that improving safety, particularly in worker health and underground construction, is the most frequently addressed objective of IoT adoption in construction, with other focal areas including site management, infrastructure development, life cycle management, and prefabrication.

The review highlighted significant gaps in IoT-BIM integration for worker safety and underutilization of digital twins in design evaluation and lifecycle management, while emphasizing the complementary roles of various technologies including AI, blockchain, cloud and edge computing, and digital twins (Sadeghi et al., 2026).

Efficiency Enhancement Mechanisms

A predictive digital monitoring solution integrating digital twins, building information modeling (BIM), IoT sensors, and artificial intelligence demonstrated practical, scalable capabilities for real-time construction resource monitoring, supporting efficient and sustainable construction resource management through integrated digital twin–site resource monitoring (Zhou et al., 2025). AIoT-powered drones have found applications across diverse construction sectors including land surveying and site selection, site layout, analytics and logistical planning, quality and progress monitoring, safety management, regulatory compliance, facility and asset management, and disaster management (Gbadamosi et al., 2025).

A quantitative investigation into IoT implementation on construction sites identified safety monitoring (impact factor 0.369) and efficiency monitoring (impact factor 0.222) as crucial enablers for successful IoT integration, leading to safer and more productive construction operations (Oke et al., 2024). IoT sensors are particularly effective for monitoring structural integrity, environmental conditions, and urban utilities, enhancing safety and efficiency in areas like traffic and waste management, with findings suggesting that IoT-driven infrastructure improves efficiency, sustainability, and resilience, though requiring more comprehensive analysis and integration in remote and rural areas (Li et al., 2025).

Integration with Enabling Technologies

The integration of IoT with artificial intelligence, blockchain, cloud and edge computing, BIM, and digital twins represents a significant advancement in project management efficiency. A blockchain-based monitoring framework equipped with an IoT component to facilitate monitoring tasks enhances security by ensuring the authenticity of data collected from construction sites (Alsamhi et al., 2025). The integration of smart products and services in the IoT era, combining technical-physical components with data-driven services, enables sustainable and beneficial IoT-based project management models that extend beyond standalone technical solutions (Beverungen et al., 2019).

The Digital Ethiopia 2030 strategy explicitly harnesses technologies including AI, IoT, and blockchain for inclusive growth, economic competitiveness, and sovereignty (Digital Ethiopia 2030, 2025). Under this framework, efforts focus on building resilient digital infrastructure, upgrading public infrastructure, establishing incident response centers, and strengthening cybersecurity across both government and private institutions (FDRE Ministry of Innovation and Technology, 2025).

Performance Evidence and Limitations in the Ethiopian Context

Empirical evidence from the Ethiopian context demonstrates strong positive relationships between technology utilization and project success, with technology explaining 76.0% of the variance in project success and showing significant associations with budget adherence and communication efficiency (Asefa, 2024). In the energy sector, field-tested smart grid monitoring solutions designed specifically for unorganized energy systems in developing countries have demonstrated practical approaches for imbalance loading and loss analysis, paving the way for more stable and efficient energy systems (Lehner & Stork, 2024). In the agricultural sector, IoT-based smart irrigation systems

measuring eight types of soil data have been successfully deployed in Ethiopia's Somali and Afar regions, empowering remote farmers with no access to electricity or formal education to manage crops effectively (ENA, 2025). Machine learning–integrated IoT systems have achieved 97% accuracy in predicting suitable crops for specific areas, demonstrating the potential for data-driven agricultural planning (Wuletaw et al., 2022).

However, significant limitations persist. High device costs deter local businesses, limited network infrastructure and connectivity issues prevent seamless communication between devices in many regions, and a scarcity of skilled IT professionals constrains implementation capacity (6Wresearch, 2025). The critical question raised at the PMI Ethiopia Chapter discussion—whether digital transformation is premature given Ethiopia's uneven digital infrastructure—encapsulates the fundamental tension between technological potential and implementation reality in the Ethiopian context.

3.9 Discussion

The results presented in Section 3 reveal a complex landscape of IoT applications in Ethiopian project management, characterized by measurable efficiency gains alongside persistent structural barriers. This discussion synthesizes the findings across sectors, examines the implications of corruption as a cross-cutting challenge, evaluates the overall efficiency contributions of IoT, and identifies critical gaps requiring further investigation.

3.10 Mapping IoT Applications to Sustainable Project Management

The evidence reveals three primary pathways through which IoT contributes to sustainable project management in Ethiopia. First, IoT enhances economic sustainability through efficiency gains. Asefa (2024) found that technology explains 76.0% of the variance in project success, with strong positive relationships between technology utilization and budget adherence and communication efficiency. In the construction sector, wireless sensor networks for railway monitoring demonstrate reduced maintenance costs and improved asset lifecycle management (Fenta et al., 2025; Mbewe, 2018). Second, IoT supports environmental sustainability through real-time monitoring of natural resources. Agricultural applications enable precision irrigation, reducing water waste and optimizing fertilizer use (Wuletaw et al., 2022; Garuma, 2021). Smart grid applications reduce energy losses and enable renewable energy integration (Lehner & Stork, 2024). Third, social sustainability benefits emerge through improved safety monitoring in construction (Mbewe, 2018), enhanced food security through agricultural applications (Wuletaw et al., 2022), and better drought preparedness for pastoralist communities (Alemayehu, 2025; FDRE Ministry of Agriculture, 2025).

3.11 Barriers to Adoption

The literature consistently identifies several barriers to widespread IoT adoption in Ethiopia. A conference paper by Solomon (2024) specifically examines IoT adoption challenges in Ethiopia, identifying: (a) socio-economic constraints arising from limited financial resources, low digital literacy rates, and inadequate awareness; (b) technological hurdles including the scarcity of skilled IT professionals and infrastructural deficits; and (c) regulatory complexities including outdated regulations, data privacy concerns, and cybersecurity gaps (Solomon, 2024). Market research confirms these challenges, noting that high device costs deter local businesses and limited network infrastructure prevents seamless communication between devices (6Wresearch, 2025). The PMI Ethiopia Chapter's discussion at Big 5 Construct Ethiopia 2026 raised a critical question: "Is digital

transformation premature given Ethiopia's uneven digital infrastructure?" This question encapsulates the fundamental tension between technological potential and implementation reality.

3.12 Corruption as a Systemic Barrier to Effective Project Management

The findings presented in Section 3.7 demonstrate that corruption is not merely an ancillary challenge but a systemic feature of Ethiopian project management that fundamentally undermines sustainability objectives. The evidence from the Federal Ethics and Anti-Corruption Commission (FEACC, 2025) documents staggering inefficiencies: irrigation projects consuming budgets seven to ten times their initial estimates while remaining incomplete for decades, and road projects requiring systematic budget overruns that point toward procurement irregularities rather than genuine technical challenges. These patterns align with Ali Mohammed's (2024) theoretical framework, which identifies information asymmetry, rent-seeking behavior, weak institutional frameworks, and neo-patrimonial governance structures as drivers of mega-corruption in Ethiopian infrastructure.

Critically, the discussion of corruption challenges intersects directly with IoT adoption in two important ways. First, corruption creates a demand-side barrier to IoT implementation: when projects are deliberately mismanaged to conceal malfeasance, transparency-enhancing technologies such as IoT sensors, real-time monitoring dashboards, and automated reporting systems are actively resisted by corrupt actors. The Ministry of Urban and Infrastructure (2025) explicitly notes that manual inspection and monitoring practices have historically allowed corruption to flourish suggesting that incumbent actors may perceive IoT as a threat to established rent-seeking arrangements. Second, IoT technologies are increasingly positioned as anti-corruption countermeasures. The Construction Regulation Information System (CRIS) launched in October 2025 (INSA, 2025) and the National Corruption Crime Reporting Digital System (NCRS) (ENA, 2024) represent deliberate efforts to use digital monitoring to reduce opportunities for graft.

However, The Reporter Ethiopia (2025) cautions that digitizing procurement systems cannot eliminate corruption as long as legal loopholes, such as ministerial powers to order direct procurement remain. This finding underscores a crucial insight: IoT alone cannot solve corruption; it must be accompanied by institutional reforms that close the discretionary spaces that enable corrupt behavior.

From a sustainable project management perspective, corruption imposes severe costs on all three sustainability dimensions. Economically, funds are diverted from project execution to private enrichment, leading to cost overruns that averaged 700% in the documented irrigation projects (FEACC, 2025). Environmentally, corrupted projects often use substandard materials and bypass environmental impact assessments, resulting in ecological damage. Socially, communities receive incomplete or unsafe infrastructure, eroding public trust and perpetuating cycles of poverty. The Ethiopian Auditor General (2024) documented losses of 17 billion Birr across 41 projects, representing resources that could have delivered substantial development outcomes. Thus, any comprehensive strategy for IoT-enabled sustainable project management in Ethiopia must confront corruption as a first-order constraint rather than an external nuisance.

3.13 Overall Efficiency of Project Management with IoT: Empirical Evidence and Limitations

Section 3.8 synthesized evidence demonstrating that IoT integration significantly enhances project management efficiency across multiple dimensions. The systematic review by Tighnavard and Sher (2026) confirms a marked transition from standalone sensing applications to integrated, intelligent, and predictive systems, with real-time monitoring, wireless sensor networks, safety improvement, BIM and digital twin integration, and resource and energy optimization as the five main application domains. The scientometric review by Sadeghi et al. (2026) adds that improving safety, particularly in worker health and underground construction is the most frequently addressed objective, followed by site management, infrastructure development, life cycle management, and prefabrication.

In the Ethiopian context, several studies provide quantitative evidence of efficiency gains. Asefa (2024) established that technology explains 76% of the variance in project success, with significant positive associations with budget adherence and communication efficiency—findings that align with global meta-analyses. In agriculture, the IoT-based smart irrigation system deployed in the Somali and Afar regions (ENA, 2025) enables remote farmers with no electricity access to manage crops effectively; demonstrating that appropriately designed low-cost IoT solutions can function even in infrastructure-poor environments. The 97% accuracy achieved by the machine learning–integrated IoT crop prediction system (Wuletaw et al., 2022) illustrates the potential for data-driven agricultural planning to reduce input waste and increase yields. In energy, the low-cost smart grid monitoring solution field-tested in Harar (Lehner & Stork, 2024) provides a practical approach for imbalance loading and loss analysis, contributing to grid stability and reduced technical losses.

However, the efficiency discussion must be tempered by several caveats. First, the documented efficiency gains are predominantly from pilot projects or controlled studies; longitudinal evidence of sustained efficiency improvements in routine operations is lacking. Second, the digital divide in Ethiopia means that efficiency benefits are unevenly distributed. Urban infrastructure projects and large commercial farms have access to connectivity and technical expertise that rural smallholders and municipal governments lack. Third, efficiency gains in one dimension may come at the cost of other sustainability dimensions if not carefully managed. For example, IoT sensors and devices require rare earth minerals and generate electronic waste, creating environmental burdens that are rarely accounted for in project-level analyses (Beverungen et al., 2019). Fourth, the integration of IoT with enabling technologies—AI, blockchain, BIM, digital twins—remains nascent in Ethiopia, despite global evidence that such integration yields the largest efficiency improvements (Zhou et al., 2025; Gbadamosi et al., 2025). The finding that only 10% of firms use AI despite 67% recognizing its value for fraud detection (Tesfaye et al., 2025) highlights a substantial adoption–awareness gap.

A particularly important efficiency consideration relates to the interaction between IoT and corruption. In theory, IoT-enabled transparency should reduce corruption by making malfeasance more detectable and thus less attractive. In practice, the efficiency gains from IoT may be partially or fully offset by corrupt actors who capture the technology or subvert its outputs. For example, if IoT sensors are deployed but corrupt officials falsify the data they transmit, or if procurement systems are digitized but ministers retain direct procurement powers (The Reporter Ethiopia, 2025), then the anticipated efficiency improvements will not materialize. This suggests that IoT investments should be sequenced with institutional anti-corruption reforms; deploying technology into a corrupt system without changing incentive structures may yield disappointing returns.

3.14 Gaps in the Literature

Several significant gaps emerge from this systematic review. First, there is a notable lack of longitudinal studies tracking IoT project outcomes over extended timeframes. Most available evidence comes from pilot projects or thesis research without post-implementation evaluation. Second, comparative studies examining the cost-effectiveness of IoT versus traditional monitoring methods in Ethiopian settings are absent. Third, research on IoT for sustainable project management in social sectors such as health and education is severely limited. Fourth, studies examining data governance, privacy, and security frameworks specific to Ethiopian IoT deployment are virtually non-existent. Fifth, the integration of IoT with other emerging technologies (AI, blockchain, BIM) in

project management contexts remains underexplored. Sixth, and critically, there is almost no empirical research on the political economy of IoT adoption—specifically, how corruption networks resist or co-opt transparency-enhancing technologies, and under what conditions IoT can serve as an effective anti-corruption tool. Seventh, research on inclusive IoT design for marginalized communities—including pastoralists, smallholder farmers, and informal workers—is sparse despite evidence of successful pilot projects (Alemayehu, 2025; ENA, 2025). Eighth, there is no published cost-benefit analysis of IoT deployment in Ethiopian public infrastructure projects, leaving policymakers without the economic evidence needed to prioritize investments.

IV. Conclusion

This systematic review has synthesized the available evidence on Internet of Things (IoT) applications in sustainable project management within the Ethiopian context, drawing from 23 core studies spanning construction, agriculture, energy, environmental monitoring, and urban development. The findings reveal that IoT technologies are progressively being deployed across multiple sectors, with demonstrable contributions to economic, environmental, and social sustainability. However, the evidence also underscores that adoption remains uneven, constrained by infrastructural deficits, cost barriers, skill shortages, and—critically—systemic corruption that undermines project integrity and efficiency.

4.1 Summary of Key Findings

First, IoT applications in Ethiopia are concentrated in four primary domains. In construction and infrastructure, wireless sensor networks for railway monitoring (Fenta et al., 2025; Mbewe, 2018) and intelligent construction frameworks integrating BIM and AI-driven risk forecasting (Demeke, 2025) have demonstrated technical feasibility and potential for real-time safety monitoring and resource optimization. In agriculture, smart irrigation systems deployed in the Somali and Afar regions (ENA, 2025) and machine learning–integrated crop prediction models achieving 97% accuracy (Wuletaw et al., 2022) illustrate how IoT can enhance food security and water efficiency for smallholder farmers. In energy, low-cost smart grid monitoring solutions field-tested in Harar (Lehner & Stork, 2024) and the Smart e Meter initiative (KIT, 2023) offer pathways to reduce technical losses and improve grid stability. In environmental monitoring, IoT prototypes for urban tree management under the Green Legacy Programme (Garuma, 2021) and satellite-integrated water and pasture early warning systems (Alemayehu, 2025) demonstrate applications for climate adaptation and ecosystem stewardship.

Second, the quantitative evidence confirms that technology utilization is a strong predictor of project success. Asefa (2024) found that technology explains 76.0% of the variance in project success, with significant positive relationships with budget adherence and communication efficiency. Global systematic reviews (Tighnavard & Sher, 2026; Sadeghi et al., 2026) corroborate that IoT enables real-time monitoring, safety improvement, resource optimization, and lifecycle management, with a marked transition from standalone sensing to integrated predictive systems involving BIM, digital twins, and AI.

Third, corruption emerges as a systemic barrier that fundamentally undermines sustainable project management. Evidence from the Federal Ethics and Anti-Corruption Commission (FEACC, 2025) documents irrigation projects consuming budgets seven to ten times initial estimates while remaining incomplete for decades, road projects with systematic budget overruns, and documented losses of 17 billion Birr across 41 projects (Ethiopian Auditor

General, 2024). Ali Mohammed (2024) identifies information asymmetry, rent-seeking, weak institutions, and neo-patrimonial governance as drivers of mega-corruption. Critically, corruption interacts with IoT adoption in two opposing directions: corrupt actors may resist transparency-enhancing technologies, while digital monitoring systems such as the Construction Regulation Information System (INSA, 2025) and the National Corruption Crime Reporting Digital System (ENA, 2024) are being deployed as countermeasures. However, as The Reporter Ethiopia (2025) cautions, technology cannot eliminate corruption as long as legal loopholes—such as ministerial powers to order direct procurement—remain. Fourth, the overall efficiency of project management with IoT, while promising, is contingent on enabling conditions. The integration of IoT with AI, blockchain, cloud computing, and digital twins yields the largest efficiency improvements globally (Zhou et al., 2025; Gbadosi et al., 2025; Alsamhi et al., 2025). In Ethiopia, efficiency gains have been documented in pilot settings, but longitudinal evidence of sustained improvements in routine operations is lacking.

Moreover, the digital divide means that benefits are unevenly distributed, with urban infrastructure and large commercial farms having greater access to connectivity and technical expertise than rural smallholders and municipal governments. Furthermore, efficiency gains may be partially offset by corrupt capture of IoT systems or by the environmental costs of IoT devices themselves (Beverungen et al., 2019).

4.2 Implications for Policy and Practice

Several implications arise for policymakers, project managers, and development partners. First, IoT investments should be sequenced with institutional anti-corruption reforms. Deploying sensors and dashboards into a corrupt system without changing incentive structures—such as eliminating discretionary direct procurement powers and strengthening independent audit mechanisms—is unlikely to yield anticipated returns. The Digital Ethiopia 2030 strategy (FDRE Ministry of Innovation and Technology, 2025) provides an enabling framework, but its anti-corruption provisions require operationalization through binding regulations and enforcement mechanisms.

Second, infrastructure deficits—particularly unreliable electricity and limited internet connectivity in rural areas—must be addressed as prerequisites for widespread IoT adoption. The successful deployment of low-power, off-grid IoT solutions in Ethiopia's Somali and Afar regions (ENA, 2025) demonstrates that appropriate technology design can partially overcome these constraints, but scaling such solutions requires targeted investment in rural digital infrastructure.

Third, capacity building at multiple levels is essential. The scarcity of skilled IT professionals (Solomon, 2024) and low digital literacy among project staff (Asefa, 2024) constrain implementation. Universities and technical colleges should integrate IoT and data analytics into engineering and project management curricula, while short-term training programs should target practicing professionals in government and industry.

Fourth, cost-effectiveness analyses are urgently needed to guide resource allocation. Policymakers currently lack the economic evidence required to compare IoT investments with alternative interventions, such as additional manual inspectors, community-based monitoring, or traditional automation. Pilot projects should include rigorous cost-benefit evaluations with clear metrics for sustainability outcomes.

4.3 Limitations of the Review

This review has several limitations that temper the generalizability of its findings. First, the quantity and quality of available evidence are limited. Many included studies are graduate theses rather than peer-reviewed publications, with correspondingly variable methodological

rigor. Second, publication bias may favour positive outcomes; failed or challenging IoT implementations are likely underreported. Third, grey literature from market research sources (e.g., 6Wresearch, 2025) provides useful trend data but lacks methodological transparency. Fourth, the absence of DOIs for many Ethiopian theses and institutional reports restricts full citation traceability, although every effort has been made to provide accessible links. Fifth, the review does not include primary data collection or meta-analysis due to heterogeneity in study designs and outcome measures. Sixth, the rapidly evolving nature of IoT technology means that some findings may become outdated quickly; the review reflects the evidence base available up to mid-2026.

4.4 Directions for Future Research

Based on the gaps identified in this review, future research should prioritize the following areas:

- Longitudinal evaluation studies. There is a critical need for multi-year, post-implementation evaluations of IoT projects across sectors, tracking sustainability outcomes, cost savings, maintenance requirements, and user adoption over time.
- Cost-benefit and cost-effectiveness analyses. Comparative studies should quantify the economic returns of IoT versus conventional monitoring methods in Ethiopian settings, incorporating environmental and social externalities.
- Political economy of IoT adoption. Empirical research is needed on how corruption networks resist or co-opt transparency-enhancing technologies, and under what conditions IoT can serve as an effective anti-corruption tool. Qualitative case studies of successful and failed digital monitoring initiatives would be particularly valuable.
- Inclusive IoT design for marginalized communities. Research should focus on co-designing IoT solutions with pastoralists, smallholder farmers, informal workers, and people with disabilities to ensure that technological benefits are equitably distributed (Alemayehu, 2025, provides a model).
- Data governance, privacy, and security frameworks. Studies should examine the legal and institutional frameworks required for IoT data collection, storage, and sharing in Ethiopia, addressing concerns about surveillance, consent, and data sovereignty (Tesfaye et al., 2025, notes that 75% of firms cite data privacy concerns as a barrier).
- Integration of IoT with AI, blockchain, and BIM in Ethiopian project management. Despite global evidence of synergies, research on integrated digital solutions in the Ethiopian context remains virtually absent. Pilot studies of digital twin-enabled construction management or blockchain-secured supply chain monitoring would be impactful.
- Capacity building and skills development. Research should identify effective models for training project managers, engineers, and technicians in IoT deployment and data utilization, including appropriate pedagogies for low-resource settings.
- Environmental lifecycle assessment of IoT systems. Studies should quantify the carbon footprint, e-waste generation, and resource extraction impacts of IoT devices deployed in Ethiopia, ensuring that sustainability gains in one domain do not create burdens in another.

5.5 Concluding Remarks

As Ethiopia continues its ambitious infrastructure development trajectory, including the Digital Ethiopia 2030 strategy, smart city initiatives across 275 towns, and the Green Legacy Programme, the role of IoT in supporting sustainable project outcomes warrants continued rigorous investigation.. The evidence to date indicates that IoT can contribute meaningfully to efficiency, transparency, and resilience, but only when deployed as part of a broader

institutional reform agenda that addresses corruption, infrastructure deficits, and capacity constraints. Technology alone is not a panacea. The question raised at the PMI Ethiopia Chapter discussion “Is digital transformation premature given Ethiopia’s uneven digital infrastructure?” finds a nuanced answer: not premature, but conditional. Where enabling conditions exist, IoT can deliver substantial benefits; where they do not, investments risk being captured, subverted, or wasted. Future research and practice must therefore focus not only on technological innovation but also on the political, institutional, and social ecosystems within which IoT operates.

References

- Addis Media Network. (2025, December 26). Digital Ethiopia 2030 turns Addis Ababa’s smart city plan into reality. <https://www.amn.gov.et/en/digital-ethiopia-2030-turns-addis-ababas-smart-city-plan-into-reality/>[reference:0]
- Alemayehu, S. (2025). Turning drought warnings into action in Ethiopia. Alliance of Bioversity International and CIAT. <https://alliancebioversityciat.org/stories/satellites-soil-turning-drought-warnings-action-ethiopia-drylands>[reference:1]
- Ali Mohammed, A. (2024). Mega corruptions in mega projects: Debating the dynamics of dam construction in Ethiopia. *F1000Research*, 13, 1179. <https://doi.org/10.12688/f1000research.155561.1>
- Alsamhi, S. H., Ma, O., & Ansari, M. S. (2025). Blockchain-based framework for construction regulations monitoring. *IEEE Transactions on Engineering Management*. <https://doi.org/10.1109/TEM.2025.3520341>
- Asefa, Y. (2024). Evaluating the influence of technology on project development and administration in Ethiopia [Master’s thesis, St. Mary’s University]. St. Mary’s University Institutional Repository. <http://hdl.handle.net/123456789/8405>
- Beverungen, D., Müller, O., Matzner, M., Mendling, J., & vom Brocke, J. (2019). Integration von smarten Produkten und Dienstleistungen im IoT-Zeitalter: Ein graphbasierter Entwicklungsansatz. *HMD Praxis der Wirtschaftsinformatik*, 56(6), 1207–1225. <https://doi.org/10.1365/s40702-019-00575-2>
- Demeke, C. S. (2025). Critical success factors and the integration of intelligent construction technologies in road projects: Evidence from Dessie, Ethiopia. *Journal of Intelligent Construction*. <https://doi.org/10.26599/JIC.2025.9180106>[reference:3][reference:4]
- Demeke, D., Gebremedhin, A., & Tadesse, M. (2026). Smart meters for firms in Ethiopia: Evidence from a randomised experiment. International Growth Centre. <https://www.theigc.org/publications/smart-meters-firms-ethiopia-evidence-randomised-experiment>[reference:5]
- Digital Ethiopia 2030. (2025). Digital Ethiopia 2030 strategy: Harnessing AI, IoT, and blockchain for inclusive growth. FDRE Ministry of Innovation and Technology.
- ENA (Ethiopian News Agency). (2024, October 3). DPM Temesgen launches Nat’l Corruption Crime Reporting Digital System (NCRS). https://www.ena.et/web/eng/w/eng_5235593
- ENA (Ethiopian News Agency). (2025, August 26). Ethiopia triumphs at 2025 BRICS skills contest, committed to intensify support: Ministry. https://www.ena.et/web/eng/w/eng_7205354
- Ethiopian Auditor General. (2024). *Annual audit report on federal government accounts for the 2022/23 fiscal year*. Office of the Auditor General.
- Ethiopian Press Agency. (2024, December 13). Corruption reporting improves since digital system introduction: Commission. Press.et. <https://press.et>

- Ethiopian Space Science and Geospatial Institute. (2024, August 26). Digital address system agreement signed for Bahir Dar. <https://ssgi.gov.et/amp/digital-address-system-agreement-signed-for-bahir-dar/>[reference:7]
- FDRE Ministry of Agriculture. (2025, May 23). User-centered water and pasture monitoring and early warning system training has been held. <https://www.moa.gov.et/user-centered-water-and-pasture-monitoring-and-early-warning-system-training-has-been-held/>[reference:8]
- FDRE Ministry of Innovation and Technology. (2025). Digital Ethiopia 2030: Implementation progress report.
- FEACC (Federal Ethics and Anti-Corruption Commission). (2025). Irrigation and lowland areas sectoral irrigation projects contract administration accountability and responsibility study. FEACC Publications.
- Fenta, T. G., Desta, E. T., & Fayaz, F. (2025). Wireless sensor network node deployment strategy in the case of Ethio-Djibouti railway. *Bahir Dar University Journal of Engineering and Technology*, 3(1). <https://doi.org/10.20372/pjet.v3i1.1877>[reference:9]
- FurtherAfrica. (2025, March 26). Ethiopia's Deputy PM calls for tech-driven modernisation in anti-corruption fight. <https://furtherafrica.com/2025/03/26/ethiopias-deputy-pm-calls-for-tech-driven-modernisation-in-anti-corruption-fight/>
- Garuma, G. (2021). Monitoring environmental conditions for urban trees plantation and growth using Internet of Things (IoT): The case of Green Legacy Program [Master's thesis, St. Mary's University]. St. Mary's University Institutional Repository. <http://hdl.handle.net/123456789/6230>[reference:10]
- Gbadamosi, A.-Q., Oyedele, L., Delgado, J. M. D., Kusimo, H., Akanbi, L., Olawale, O., & Muhammed-Yakubu, N. (2025). AIoT-powered drones in the construction industry: A review. *Automation in Construction*, 169, 105828. <https://doi.org/10.1016/j.autcon.2025.105828>
- Gebremedhin, T., Alemu, B., & Demissie, T. (2024). Transforming agriculture with Machine Learning, Deep Learning, and IoT: Perspectives from Ethiopia—challenges and opportunities. *Discover Agriculture*, 2, Article 63. <https://doi.org/10.1007/s44279-024-00066-7>[reference:11]
- INSA (Information Network Security Administration). (2025, October 7). Ethiopian Construction Authority officially launches Construction Regulation Information System in collaboration with INSA. <https://insa.gov.et>
- KIT (Karlsruhe Institute of Technology). (2023, June 22). Smart e Meter. Institute of Information Processing Technology. https://www.itiv.kit.edu/english/294_10522.php[reference:12]
- KIT (Karlsruhe Institute of Technology). (2026, March 4). MoU signing between EEU, GIZ, and KIT. Institute of Information Processing Technology. <https://www.itiv.kit.edu/english/11360.php>[reference:13]
- KIT (Karlsruhe Institute of Technology). (2025). MoRaU – Monitoring and modelling of urbanization in sub-Saharan Africa. Institute of Information Processing Technology. https://www.itiv.kit.edu/english/294_11228.php[reference:14]
- Lehner, M., & Stork, W. (2024). Application and use-cases for a smart distribution grid in developing countries. In *Proceedings of the 2024 International Conference on Electrical and Computer Engineering Researches (ICECER)* (pp. 1–6). Gaborone, Botswana. IEEE. <https://publikationen.bibliothek.kit.edu/1000181713>[reference:15]
- Li, Y., Zhang, J., & Wang, H. (2025). Smart infrastructure systems: A review of IoT-enabled monitoring and automation in civil and agricultural engineering. *Journal of Infrastructure Systems*, 31(2), 04025008. [https://doi.org/10.1061/\(ASCE\)IS.1943-555X.0000892](https://doi.org/10.1061/(ASCE)IS.1943-555X.0000892)
- Mbewe, A. S. (2018). Railway infrastructure monitoring using wireless sensor networks [Master's thesis, Addis Ababa University]. Addis Ababa University Institutional Repository.

- Ministry of Urban and Infrastructure. (2025). Construction industry transformation initiative: Ease of doing business reform framework in construction sector. Federal Democratic Republic of Ethiopia. <https://mui.gov.et>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, 6(7), e1000097.
- Oke, A. E., Aigbavboa, C. O., & Mabena, S. (2024). Internet of things (IoT) for safety and efficiency in construction building site operations. *Journal of Engineering, Design and Technology*. <https://doi.org/10.1108/JEDT-09-2023-0423>
- Sadeghi, J., Ahmadi, A., & Phipps, R. (2026). Internet of things in construction: Trends and adoption insights from a scientometric perspective. *International Journal of Construction Management*, 26(1), 113–130. <https://doi.org/10.1080/15623599.2025.2494472>
- Solomon, D. D. (2024). Challenges of IoT adoption in developing countries: A case study of Ethiopia. In *Proceedings of the 2024 IEEE DELCON Conference*. IEEE. [https://ieeexplore.ieee.org/document/10867084/\[reference:17\]](https://ieeexplore.ieee.org/document/10867084/[reference:17])
- Tesfaye, B., Alemu, M., & Demissie, T. (2025). Digital technologies and trade facilitation in Ethiopia: A mixed-methods analysis of blockchain, AI, and IoT adoption. *Journal of African Business*, 26(2), 245–267. <https://doi.org/10.1080/15228916.2025.2156341>
- The Reporter Ethiopia. (2025, July 19). Unchecked privilege: Divisive directive casts doubt on integrity in public procurement. *The Reporter Ethiopia*. <https://www.thereporterethiopia.com>
- The Reporter Ethiopia. (2025, October 4). The pitfalls of exploiting mega projects for political mileage. *The Reporter Ethiopia*. <https://www.thereporterethiopia.com/47274/>
- Tighnavard, A. B., & Sher, W. (2026). A systematic literature review of Internet of Things (IoT) applications in sustainable construction project management. *Sustainability*, 18(5), 2614. <https://doi.org/10.3390/su18052614>
- TrendsNAfrica. (2026, March 9). Ethiopia streamlines public procurement system. <https://trendsnafrica.com>
- Wuletaw, Z., Ababu, K., & Birhanie, W. (2022). Smart farming using IoT and machine learning in Jimma city Jiren kebele [Master's thesis, Jimma University]. Jimma University Institutional Repository. <https://repository.ju.edu.et/handle/123456789/7874>
- Zhou, C., Ding, L., & Luo, H. (2025). Predictive digital monitoring of construction resources: An integrated digital twin solution. *Automation in Construction*, 160, 105678. <https://doi.org/10.1016/j.autcon.2025.105678>
- 6Wresearch. (2025). Ethiopia IoT in commercial construction market (2025–2030). 6Wresearch Market Intelligence.